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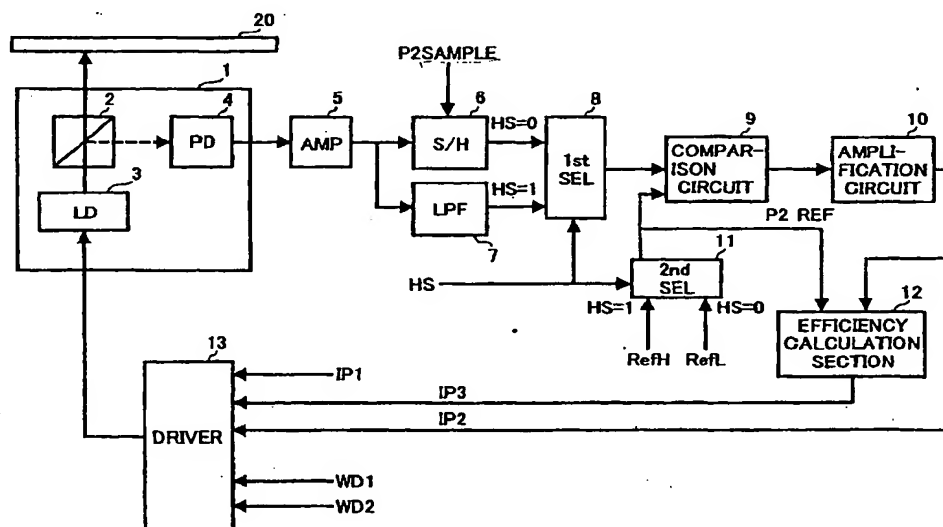
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(54) **Light intensity control and information recording apparatus and method and computer program product**

(57) A light intensity control apparatus for use in an information recording and reading system includes a light source driving device (13) for driving a light source (3) so as to generate a light having the first and higher second light intensity levels. A light intensity detection device is provided and includes a first light intensity detection member (6) for detecting a prescribed intensity level of the light when a light modulation speed is relatively low, and a second light intensity detection member (7) for detecting an average of the intensity of the light when it is relatively high. A detection member selection device (8) is provided so as to select one of the first and

second light intensity detection members depending upon a selection instruction so as to use one of the detection outputs. A reference level selection device (11) is provided so as to select one of the first and the second reference levels to be compared with the one of the detection results depending upon the selection instruction. A comparison device (9) may be provided so as to compare the one of detection results with a corresponding one of reference levels. A driving current adjustment device (13) is provided in order to adjust magnitude of a driving current that drives the light source in accordance with the comparison result.

**FIG. 1**



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## Description

### BACKGROUND OF THE INVENTION

#### Field of the Invention:

[0001] The present invention relates to an information recording apparatus such as an optical disc drive that records information in a recording medium such as a CD-R/RW disc, and in particular to a light intensity control apparatus that controls the power of light generated by a light source such as a semi-conductor laser.

#### Discussion of the Background:

[0002] Recently, use of an information recording apparatus capable of recording information in a recording medium such as a CD-R/RW disc has become wide spread. For example, an information recording apparatus proposed e.g. by Japanese Patent Application Publication No. 7-44885 has been well known. In this apparatus first, third and fourth levels of a light intensity (P1, P3 and P4) are set as optical output levels of a semiconductor laser. In addition, the remaining second intensity level ( $P2 = P1 + P4 - P3$ ) can be set from the three lower optical intensity levels (P1, P3, and P4) as a peak value of a recording pulse light because the optical intensity value P3 is smaller than P1, and the following inequality are accordingly established:

$$P4 < P2, P3 < P4 < P2$$

[0003] As a result, a needless signal (i.e., signal higher than P2) can be avoided from being recorded in the recording medium, and accordingly, deterioration of the semiconductor laser can be avoided.

[0004] Further, when some information is recorded on an optical disc, an optical disc apparatus as an information recording apparatus generally modulates a recording laser beam at a higher recording power than when information is read.

[0005] Furthermore, when a writable optical disc such as CD-R (Compact Disc Recordable) disc having an organic colorant recording coating on a recording surface is utilized, the semiconductor laser light source alternately generates light beams having light power levels P1 (of a read intensity), and P2 (of a write intensity) higher than the P1. As a result, a pit is created on a portion of the recording surface when the laser light beam is irradiated with a light power level P2, and a space remains on another portion when the laser light beam is irradiated with a light power level P1 onto the recording surface. Further, a light power level P3 higher than the P2 level is generally utilized and the recording power wave form sometimes is formed as to include three different values having P1, P2, and P3 levels. That is, the P3 level is positioned at a pit top portion so as to make

a pit edge sharp.

[0006] When a rewritable and phase changeable type recording medium such as CD-RW (Compact Disc Rewritable) disc is utilized, these three values are also utilized. Specifically, a portion of the recording surface irradiated by a laser beam generally is changed into an amorphous state (non-crystal) when the generated light power is varied at high speed between the power levels P3 and P1 repeatedly utilized. In contrast, a crystal portion is made when the P2 level is maintained. Thus, these portions can correspond to information data.

[0007] Thus, to control these several modulation intensity levels, a sampling circuit is generally utilized. Specifically, when the generated light intensity levels P1 and P2 for the CD-R use are utilized, the P2 level receives sampling and generally is compared with a prescribed reference value. Then, the laser current through the semiconductor laser light source is controlled based upon the comparison result.

[0008] Thus, the generated light power is controlled so that the generated light power P2 can be equal to the prescribed reference level (i.e., target level). In addition, since the P1 level corresponds to a reading power, the magnitude of laser current during reading generally is stored for later use.

[0009] However, in the above-described conventional information recording apparatus, since the modulation speed becomes extremely high along with increase in the recording speed, a time period of the P2 level correspondingly becomes extremely short. As a result, a high speed sampling circuit is required. However, it generally is difficult to provide such a high speed sampling circuit, or costly if provided. In addition, if an ordinary cheaper sampling circuit is utilized, the recording light power is not precise.

### SUMMARY OF THE INVENTION

[0010] Accordingly, an object of the present invention is to address and resolve the above and other problems and provide a new image processing apparatus.

[0011] The above and other objects are achieved according to the present invention by providing a novel light intensity control apparatus including a light source driving device that drives a light source by the first and second light intensity levels, a light intensity detection device that detects intensity of a light generated from the light source, a comparison device that compares the light intensity with the first and second reference levels, and a driving current adjustment device that adjusts the magnitude of a driving current that drives the light source in accordance with a result of the comparison.

[0012] In another embodiment, the light intensity detection device includes a first signal generating device that generates a signal corresponding to the intensity of light generated at the second light power level when a modulation speed is relatively low, and a second signal generating device that generates a signal correspond-

ing to an average of the intensity of the light when the modulation speed is relatively high.

[0013] In yet another embodiment, a first selection device is provided so as to select one of the first and second signal generating devices based upon a selection instruction so as to select one of detection outputs.

[0014] In yet another embodiment, the comparison device includes a reference level selection device (second selection device) that selects one of the first and the second reference levels in accordance with the selection instruction. In yet another embodiment, the selection instruction indicates a digital modulation speed of the light source. In yet another embodiment, the selection instruction controls the first selection device to select the first signal generating device, and the second selection device to select the first reference level, correspondingly, when the digital modulation speed is relatively low.

[0015] In yet another embodiment, the selection instruction controls the first selection device to select the second signal generating device, and the second selection device to select the second reference level, correspondingly, when the digital modulation speed is relatively high. In yet another embodiment, the light source driving device drives a light source by all of the first, second, and third light intensity levels. In yet another embodiment, the driving current adjustment device adjusts magnitude of the driving current so that the light source generates a light having the second reference level based upon the comparison result when the light source is driven by the second light generation level.

[0016] In yet another embodiment, the driving current adjustment device adjusts magnitude of the driving current in accordance with performance assumed or calculated from the first and second generated light levels when the light beam is generated at the third light intensity level.

#### BRIEF DESCRIPTION OF DRAWINGS

[0017] A more complete appreciation of the present invention and many of the attendant advantages thereof will be readily obtained as the same becomes better understood by reference to the following detailed description of exemplary embodiments of the present invention when considered in connection with the accompanying drawings, wherein:

- Fig. 1 is a schematic block diagram for illustrating a configuration of one embodiment of a laser power control circuit provided in an optical disc apparatus according to the present invention;
- Fig. 2 is a chart for illustrating a variety of signal wave forms utilized when light generation control is performed for a CD-R by a laser power control circuit illustrated in Fig. 1;
- Fig. 3 is also a chart for illustrating a variety of signal waves utilized when light generation control is

performed for a CD-RW by a laser power control circuit illustrated in Fig. 1;

- Fig. 4 is a schematic block diagram for illustrating an interior configuration of a driver illustrated in Fig. 1;

- Fig. 5 is a chart for illustrating a table included in the driver for showing a relation between a control logic signal and an input signal; and

- Fig. 6 is a graph for illustrating a relation between current of a laser diode (LD) illustrated in Fig. 1 and a recording power.

#### DETAILED EMBODIMENT OF THE PREFERRED EMBODIMENTS

[0018] Exemplary embodiments of the present invention will now be described with reference to the drawings, wherein like reference numerals and marks designate identical or corresponding parts throughout several views.

[0019] As shown in Fig. 1, an information recording apparatus may be provided so as to record and reproduce information by condensing a laser beam, that is generated by a semiconductor laser light source, on a recording coating formed on an optical disc 20 such as a CD-R/RW. A laser power control circuit may be provided so as to control the recording and reading power (i.e., the generated light power) of the semiconductor laser light source when information is recorded and reproduced.

[0020] One example of a recording system and its operation performed by the laser power control circuit by utilizing two different light intensity levels will now be described. A pickup 1 may include a prism or beam splitter 2, a semiconductor laser light source (LD) 3, and a photodetector (PD) 4 and so on. The LD 3 may irradiate a laser beam of a predetermined light power generated in correspondence with a driving current carried from the driver 13. The laser beam may then be imaged onto an optical disc 20 and is on the other hand irradiated to the PD 4 after reflection on a surface of the prism or beam splitter 2. When receiving the laser beam from the prism 2, the PD 4 may perform a photo-electronic conversion and output a signal in accordance with the power of the laser beam. Thus, functions of detecting and monitoring a value of generated light power of the laser beam may be achieved. The pickup 1 may also include an objective or lens system, and another optical detector capable of receiving a reflected light, or the like. It is to be understood that all sections of the pickup and all conventional sections not directly related to the present invention are neither described nor illustrated in the drawings herein.

[0021] An amplifier (Amp) 5 may amplify a generated light power monitoring signal indicating the magnitude of generated light power after the photo-electronic conversion by the PD 4. The generated light power monitoring signal may then be input to both a sample hold

circuit (S/H) 6 and a low pass filter (LPF) 7 that is a low band filter device. The S/H 6 may sample the generated light power monitoring signal when a sampling pulse signal (P2sample) is generated, and hold data of a light intensity level thereof.

[0022] As illustrated in Fig. 2(d), when the CD-R disc is utilized, the sampling pulse signal (P2sample) may be generated and input to the S/H 6 at a time period when the generated light intensity corresponds to the second light intensity level P2, which is higher than the first light intensity level P1 that is the minimum light intensity level enabling the LD 3 to generate a light beam for reading. When the CD-RW is utilized (Fig. 3), the sampling pulse signal (P2sample) may preferably be generated at the second light power level P2 of the generated light power for erasing (it is called as a recording power level similar to the P2 level for the CD-R).

[0023] The second light intensity level P2 may be higher than the generated light level P1 for reproduction use. Thus, when a CD-RW disc is utilized and a high speed modulation is performed for modulating the light intensity between the third light intensity level P3 (which is higher than the second light intensity level P2) and the first light intensity level P1 as illustrated in Fig. 3, the recording coating may be changed into an amorphous state, and accordingly, a recording mark or a pit may be formed. The second light intensity level P2 changes the recording coating into the crystal line state. Thereby an erasing mark or a land may be formed in a manner known in the art.

[0024] When a CD-R disc is utilized, a recording mark or pit may be formed on a recording surface of an optical disc 20 by a light beam at the second light intensity level P2. A space or an unwritten area may be maintained on the recording surface if the first light intensity level P1 is used that is used for data reproduction. In addition, by positioning the third light intensity level P3 at a top of the light intensity level P2, in particular at the leading edge of the pulse of light intensity P2, as illustrated in Fig. 2(d), a front edge of the recording mark may be made sharp as noted in the art. Thus, the S/H 6 may in any case output a prescribed signal in accordance with the second light intensity level P2.

[0025] The LPF 7 may allow passage of a low band part of the generated light power monitoring signal. Thus, the LPF 7 may detect an average of the generated light power output from the PD 4. As illustrated in Fig. 2 (d), when the CD-R disc is utilized, since an average (Pave) of the generated light power lies in the vicinity of the dotted line, an output of the LPF 7 may also be such a level. In contrast, as illustrated in Fig. 3 (d), when the CD-RW disc is utilized, such an output may be a level in accordance with the average (Pave).

[0026] Otherwise, the average (Pave) can be calculated from the third to first light intensity levels P3, P2, and P1, if an average duty cycle of a mark and space (i.e., an erase mark) is constant, and if the timings of generation of light power at the third to first light intensity

levels P3, P2, and P1, (i.e., modulation timing) are known. For example, if each of the levels P3 and P2 is 10 mW, and the level P1 is 1 mW, and further an average duty cycle of 50% is used, the average during modulation can be obtained from the following formula:

$$P_{ave} = (10 \times 0.5) + (1 \times 0.5) = 5.5 \text{ mW}$$

[0027] Thus, the above-described PD 4, Amp 5, S/H 6, LPF 7, and first selector (SEL) 8 may constitute the first selection device according to the present invention. The S/H 6 may serve as a first signal generating device for generating a signal corresponding to the first light intensity level. The LPF 7 may serve as a second signal generating device for generating a signal corresponding to the second light intensity level. In addition, the first selector 8 may serve as a first selection device.

[0028] The first SEL 8 may select any of the output signals from the S/H 6 and the LPF 7 depending on a selection instruction (i.e., selection of High Speed: HS). In particular, if a digital modulation speed of the LD 3, and accordingly, a speed of recording on the optical disc 20 is relatively low, the selection instruction HS may be zero (HS=0). Then, the first selector 8 may select and output an output signal from the S/H 6 to the comparison circuit 9.

[0029] In contrast, if the digital modulation speed, and accordingly, the recording speed is relatively high, the selection instruction HS may be one (HS=1). Then, the first selector 8 may select and output an output signal from the LPF 7 to the comparison circuit 9. Thus, when an operation is performed at high speed, instead of using the S/H 6, a monitoring signal that indicates an average power obtained by the LPF 7 may be utilized. Then, the comparison circuit 9 may compare a generated light power monitoring signal that is output from the first selector 8 with a reference level (P2Ref) that is output from a second selector 11. The comparison circuit 9 may then output a signal that indicates a comparison result. The reference level (P2Ref) may be a target level that the generated light power monitoring signal reaches so as to control the generated light power of the LD 3.

[0030] Thus, the comparison circuit 9 and the second selector 11 may constitute the comparison device according to the present invention. The second selector 11 may serve as the reference level selection device. In addition, the second selector 11 may select and output to the comparison circuit the first reference level Ref/L or the second reference level Ref/H as a reference level (P2/Ref) depending upon the selection instruction (HS). According to one embodiment, the reference levels Ref/L and Ref/H may be supplied by a conventional constant voltage supply unit or a D/A-converter connected e.g. to a microcomputer, as will become apparent to the person skilled in the art when studying this description.

[0031] Specifically, the second selector 11 may select and output to the comparison circuit 9 the first reference

level Ref/L if the selection instruction HS indicates a low speed (i.e., HS=0). In contrast, the second SEL 11 may select and output to the comparison circuit 9 the second reference level Ref/H if the selection instruction HS indicates a high speed (i.e., HS=1).

[0032] Since the first reference level Ref/L is selected when the sample hold value of the second light intensity level P2 is selected as a generated light power monitoring signal, a prescribed level corresponding to the second light intensity level P2 may be set for the Ref/L. Since the second reference level Ref/H is selected when an average value is selected as a generated light power monitoring signal, a prescribed level corresponding to the average intensity level may be set for the Ref/H.

[0033] The amplification circuit 10 may amplify a comparison result indication signal that is output from the comparison circuit 9. A signal IP2 (described later in detail) may be output from the amplification circuit 10 and then input to the driver 13. The driver 13 may drive a driving current of magnitude proportional to the output signal IP2 through the LD 3 only when a recording pulse WD2 formed from write data (WDATA) and input thereto has a high level ("H"). Thus, the generated light power of the LD 3 can be adjusted. The driver 13 may drive a driving current of magnitude proportional to the level of the input signal IP1 through the LD 3 when the pulse WD2 has a low level ("L"). Thus, the generated light power of the LD 3 can be adjusted.

[0034] Accordingly, the driver 13 may serve as the light source driving device and driving current adjusting device according to the present invention.

[0035] Further, the above-noted selection instruction may control the first selection device to select the first signal generating device, and the second selection device to select the first light reference level (i.e., Ref/L) when a digital modulation speed of the light source is relatively low. Moreover, it may control the first selection device to select the second signal generating device, and the second selection device to select the second light reference level (i.e., Ref/H), when the digital modulation speed of the light source is relatively high.

[0036] In the above-described laser power control circuit, for a level of the input signal IP1, an appropriate laser current may preferably be stored during reproduction (i.e., the LD 3 is generating a light beam at the first light intensity level P1) and then given when recording is performed. A conventional control device not illustrated in the drawings may be provided so as to control the reproducing light power to be constant at the first light intensity level P1. For example, a generated light power monitoring signal of the first light intensity level P1 may be compared with the reference level and then amplified. The generated light power monitoring signal may then be applied to the driver 13 as an input signal IP1. Such an input signal IP1 may preferably be stored in an appropriate memory. For example, the input signal IP1 can be formed by digitalization by means of an A/D converter and stored in a latch circuit, and can then be re-

turned as an analogous signal by means of the D/A converter using the known technique in the art.

[0037] Another example of a recording control operation performed in this laser power control circuit using three different light intensity levels is now described. The interior configuration of the driver 13 of this example is illustrated in Fig. 4. Specifically, the first to third current sources 22, 23, and 24 may be provided to respectively generate a driving current of magnitude proportional to the level of each of the control-input signals IP1, IP2, and IP3. The first to third switches 25, 26 and 27 may be opened and closed by control logic signals SW1, SW2, and SW3 generated by the logic section 21 in accordance with combinations of input signals WD1 and WD2. The logic section 21 may be configured to switch over and carry a driving current to the LD 3 so that the LD 3 can generate a laser beam having a prescribed generated light power level corresponding to the first to third light intensity levels P1 to P3 based upon the input signals WD1 and WD2.

[0038] In Fig. 5, one example of a table showing relations between statuses of the control logic signals SW1 to SW3 and input signals WD1 and WD2 is illustrated. As noted therefrom, when both input signals WD1 and WD2 are in a low state (L), the control logic signal switch SW1 may be turned ON. Then, a driving current having a magnitude corresponding to the control input signal IP1 (i.e., the first light intensity level P1) may be carried to the LD 3. When the input signals WD1 and WD2 are in a high state (H) and in a low state (L), respectively, the control logic signal switch SW3 may be turned ON. Then, a driving current having a magnitude corresponding to the control input signal IP3 (i.e., the third light intensity level P3) may be carried to the LD 3. When the input signals WD1 and WD2 are in the states of L and H, respectively, the control logic signal switch SW2 may be turned ON. Then, a driving current having a magnitude corresponding to the control input signal IP2 (i.e., the second light intensity level P2) may be carried to the LD 3.

[0039] Even though the driver 13 carries the driving current corresponding to the first to third (i.e., three) light intensity levels P1 to P3 in the above-described embodiment, an operation using only the first and second light intensity levels P1 and P2 (i.e., two) may be sufficient if the recording performance of the recording coating can be satisfied. For example, two levels of the light intensity may be enough for a recording coating of a certain type of an organic colorant series used for example for a CD-R disc. (For the phase change recording coating such as a CD-RW disc, since three levels are generally required, the three levels of light intensity may be appropriate). When only the two levels are utilized, it is desirable that the input signal WD1 is maintained at a low level (L), and a signal substantially the same to the recording data WDATA is input for the input signal WD2.

[0040] Furthermore, even though the above-described embodiments exemplify a case wherein, when

any one of the control logic signal switches SW1 to SW3 is turned ON, a driving current having a magnitude corresponding to any one of the first to third control input signals IP1 to IP3 is carried to the LD 3, the present invention is not limited to those and a current accumulation type described below may be employed instead. Specifically, for the first light intensity level P1 (corresponding to the control input signal IP1), the first control logic signal switch SW1 may be turned ON. For the second light intensity level P2 (corresponding to the sum of the control input signals IP1 and IP2), the first and second control logic signal switches SW1 and SW2 may simultaneously be turned ON. Further, for the third light intensity level P3 (corresponding to the sum of the control input signal IP1, IP2, and IP3), the first, second and third control logic signal switches SW1, SW2, and SW3 may simultaneously be turned ON.

**[0041]** Such a current accumulation type may readily be realized, if its logic formed from combinations of timings of the input signals WD1 and WD2 is changed in a design in accordance with power level generation timings as appropriate.

**[0042]** One example of a desirable operation using light powers with two different level (i.e., the first and second light intensity levels P1 and P2) is now described. Initially, the driver 13 may hold a level corresponding to a driving current carried when the LD 3 is controlled at a reproduction power as a control-input signal IP1. Then, the selection instruction HS may be zero (HS=0) when the recording speed is relatively low. Otherwise, the selection instruction HS may be one (HS=1) when the recording speed is relatively high. In addition, the input signal WD1 may be maintained at a low level (L) for the reason noted earlier. Furthermore, a signal substantially the same as the recording data pulse WDATA may be input to the driver 13 as an input signal WD2.

**[0043]** Then, as described above, a sample value of the second light intensity level P2 or an average value may be selected by the selection instruction HS as a generated light power monitoring signal. Simultaneously, the reference level (P2Ref) may be selected correspondingly as a target power level. Thus, the second light intensity level P2 of the LD 3 can be controlled at around a prescribed target level all of when a recording speed is high and low without employing a high speed sampling circuit.

**[0044]** Another example of a generated light power control operation performed by the third light intensity level P3 is now described. The third light intensity level P3 may be calculated using the laser performance (ratio of laser power to current). Such a laser performance may be calculated from a level corresponding to the magnitude of the driving current for generating the second light intensity level P2. One example of methods for calculating the laser performance in the performance calculation section 12 is now described. It is initially assumed that the driver 13 is of the current switching type

as illustrated in Fig. 4. The laser performance can be calculated from a control input signal IP2 required when the LD 3 generates a light beam having the second light intensity level P2, and a control input signal IP1 required when the LD 3 generates a light beam having the first light intensity level P1, by employing the following formula:

$$\text{Performance} = (P2 - P1) / (IP2 - IP1)$$

**[0045]** As illustrated in Fig. 6, the laser performance may be represented by the inclination of a straight line. Thus, a control-input signal IP3 required for the LD 3 to generate a light beam having the third light intensity level P3 may be obtained from the following formula:

$$IP3 = IP1 + (P3 - P1) / \text{Performance}$$

**[0046]** As for the control input signal IP2 required for the LD 3 during generation of a light beam at the second light intensity level P2, it is desirable to set the selection instruction to zero (HS=0) and to utilize a control input signal IP2 as utilized when the second light intensity level P2 is controlled by sampling. If the laser performance value is once obtained, since a control input signal IP3 corresponding to an optional third light intensity level P3 can be calculated, no problem occurs even when the selection instruction HS is set to one.

**[0047]** In the above-described laser power control circuit of Fig. 1, the voltage of the reference level (P2Ref) is used as the second light intensity level P2 when the performance calculation section 12 calculates the performance. However, another level does not raise any problem if it simply corresponds to the second light intensity level P2. Specifically, it is sufficient to convert only the scale between the laser performance and the third light intensity level IP3 when calculation is performed. Namely, it is sufficient to perform this calculation by converting the first and third light intensity levels P1 and P3 into substantially the same unit as the reference level (P2Ref).

**[0048]** Furthermore, the laser power control circuit of the above-described embodiment can be applied to another system as a device capable of adjusting a driving current and controlling the generated light power of a light source.

**[0049]** Furthermore, even though the driving current is adjusted by two or three values of light intensity levels, the present invention is not limited thereto. Specifically, the drive current may be adjusted by four or more different light intensity levels in the similar manner.

**[0050]** According to these embodiments, since the driving current of the light source is adjusted by switching a sampling monitoring signal to and from an averaged monitoring signal depending on the recording speed, a high-speed modulation may be performed

without using a high speed sampling circuit. In addition, a light source control to generate a light beam having a prescribed power (i.e., recording intensity) can be precisely performed both in low speed and high-speed recording. Furthermore, since the generated light power is adjusted by means of three light intensity levels, the present invention can be applied to a variety of optical instruments or the like as a generated light power control apparatus.

[0051] The mechanisms and processes set forth in the present invention may be implemented using one or more conventional general purpose microprocessors and/or signal processors programmed according to the teachings in the present specification as will be appreciated by those skilled in the relevant arts. Appropriate software coding can readily be prepared by skilled programmers based on the teachings of the present disclosure, as will also be apparent to those skilled in the relevant arts. However, as will be readily apparent to those skilled in the art, the present invention also may be implemented by the preparation of application-specific integrated circuits by interconnecting an appropriate network of conventional component circuits or by a combination thereof with one or more conventional general purpose microprocessors and/or signal processors programmed accordingly. The present invention thus also includes a computer program product which may be recorded on a data recording medium and may include, but is not limited to, any type of disk including floppy disks, optical disks, CD-ROMs, magnet-optical disks, ROMs, RAMs, EPROMs, EEPROMs, flash memory, magnetic or optical cards, or any type of media suitable for storing electronic instructions.

[0052] Numerous additional modifications and variations of the present invention are possible in light of the above teachings. It is therefore to be understood that within the scope of the appended claims, the present invention may be practiced otherwise than as specifically described herein.

[0053] This application claims convention priority pursuant to Art. 87 of the European Patent Convention to Japanese Patent Application No. 2000-362713, filed on November 29, 2000, the entire contents of which being herein incorporated by reference.

## Claims

### 1. A light intensity control apparatus, comprising:

a light source driving device (13) configured to drive a light source (3) to generate light of a first light intensity level (P1) and at least of a second light intensity level (P2) higher than said first light intensity level;  
a first signal generating device (6) for generating a signal corresponding to the second light intensity level (P2);

a second signal generating device (7) for generating a signal corresponding to an average light intensity ;

a first selection device (8) configured to select one of the first and second signal generating devices (6, 7) in accordance with a selection instruction (HS);

a comparison device (9) configured to compare a signal output by one of the first and second signal generating devices (6, 7) with a reference signal; and

a driving current adjustment device (31) for adjusting a driving current through the light source (3) in accordance with the comparison result.

### 2. The light intensity control apparatus according to claim 1 further comprising

a reference providing device for providing a first and second reference signal; and

a reference selecting device (11) configured to select one of the reference signals in accordance with the selection instruction (HS) and to apply a selected reference signal to said comparison device.

### 3. The light intensity control apparatus according to claim 1 or 2, wherein said light source driving device (13) is additionally configured to drive said light source (3) to generate light of a third light intensity level higher than said first and second light intensity levels.

### 4. The light intensity control apparatus according to claim 3, wherein said third light intensity level is generated by assuming a performance of the light source referring to the first and second generated light levels.

### 5. The light intensity control apparatus according to any one of the preceding claims, wherein said light reads and/or writes information from and/or onto a recording medium.

### 6. The light intensity control apparatus according to claim 5, wherein light of said first light intensity level is used to read information from the recording medium during a reproduction mode.

### 7. The light intensity control apparatus according to claim 5, wherein light of said first light intensity level is used to form a space or land on a recording surface of the recording medium during a recording mode.

### 8. The light intensity control apparatus according to any of claims 5 to 7, wherein light of said second light intensity level is used to form a pit or an amorphous portion on a recording surface of the record-



ing medium during a recording mode.

9. The light intensity control apparatus according to any of the preceding claims, wherein said second light intensity level is detected by a sampling operation. 5
10. The light intensity control apparatus according to any one of the preceding claims, wherein a reading light intensity is detected and stored during a reproduction mode as said first light intensity level for a recording mode. 10
11. The light intensity control apparatus according to any of the preceding claims, wherein said signal corresponding to the average light intensity is detected using a low pass filter (7). 15
12. The light intensity control apparatus according to any of claims 1 to 10, wherein said signal corresponding to the average light intensity is calculated from the light intensity levels when an average duty cycle of a mark and space is constant and a modulation timing of the light intensity levels are known. 20
13. The light intensity control apparatus according to any one of claims 2 to 12, wherein said first reference signal is a prescribed value targeted by the second light intensity. 25
14. The light intensity control apparatus according to any of claims 2 to 13, wherein said second reference signal is a prescribed value targeted by the average intensity. 30
15. The light intensity control apparatus according to claims 13 and 14, wherein said first reference signal is compared with the output signal of the first signal generating device (6), and said second reference signal is compared with the average value. 35
16. The light intensity control apparatus according to any of the preceding claims, wherein said selection instruction (HS) varies depending upon a digital modulation speed of the light source. 40
17. The light intensity control apparatus according to any of the preceding claims, wherein said selection instruction (HS) controls the first selection device (8) and the second selection device (11) to select the output signal of the first signal generating device (6) and the first reference signal, respectively, when the digital modulation speed is relatively low. 45
18. The light intensity control apparatus according to any one of claims 1 to 16, wherein said selection instruction (HS) controls the first selection device (8) and the second selection device (11) to select 50

the output signal of the second signal generating device and the second reference signal, respectively, when the digital modulation speed is relatively high.

19. An information recording system configured to record information onto a recording medium, comprising:

a light source (3) for irradiating a light beam from said light source onto said recording medium, and  
a light intensity control apparatus for controlling the light intensity of said light beam,

wherein said light intensity control apparatus is configured in accordance with any of the preceding claims.

20. A computer comprising the information recording system according to claim 19. 20
21. A method for controlling light intensity, comprising the steps of: 25

driving a light source (3) so as to generate light of a first light intensity level (P1) and at least of a second light intensity level (P2) higher than said first light intensity level;  
selectively generating a first signal corresponding to the second light intensity level and a second signal corresponding to an average of the intensity of the light generated from the light source depending upon a light modulation speed of the light source;  
comparing a first and second target level with the first and second signal, respectively; and  
adjusting a magnitude of a driving current for driving the light source (3) in accordance with the comparison result. 30

22. The method according to claim 21, wherein said light source (3) optionally is driven to generate light of a third light intensity level higher than said first and second light intensity levels. 35

23. The method according to claim 21 or claim 22, wherein said first and second target level (Ref/H, Ref/L) is selected in accordance with the light modulation speed. 40

24. Computer program product comprising program code means for performing the steps according to any of claims 21 to 23, if said program is run on a data processing means of a light control apparatus or of an information recording system comprising a light intensity control apparatus according to any of claims 1 to 19. 45



25. Computer program product comprising program code means according to claim 24, that are recorded on a computer readable data carrier or in a data storage component whose memory is loadable into the data processing means.

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FIG. 1

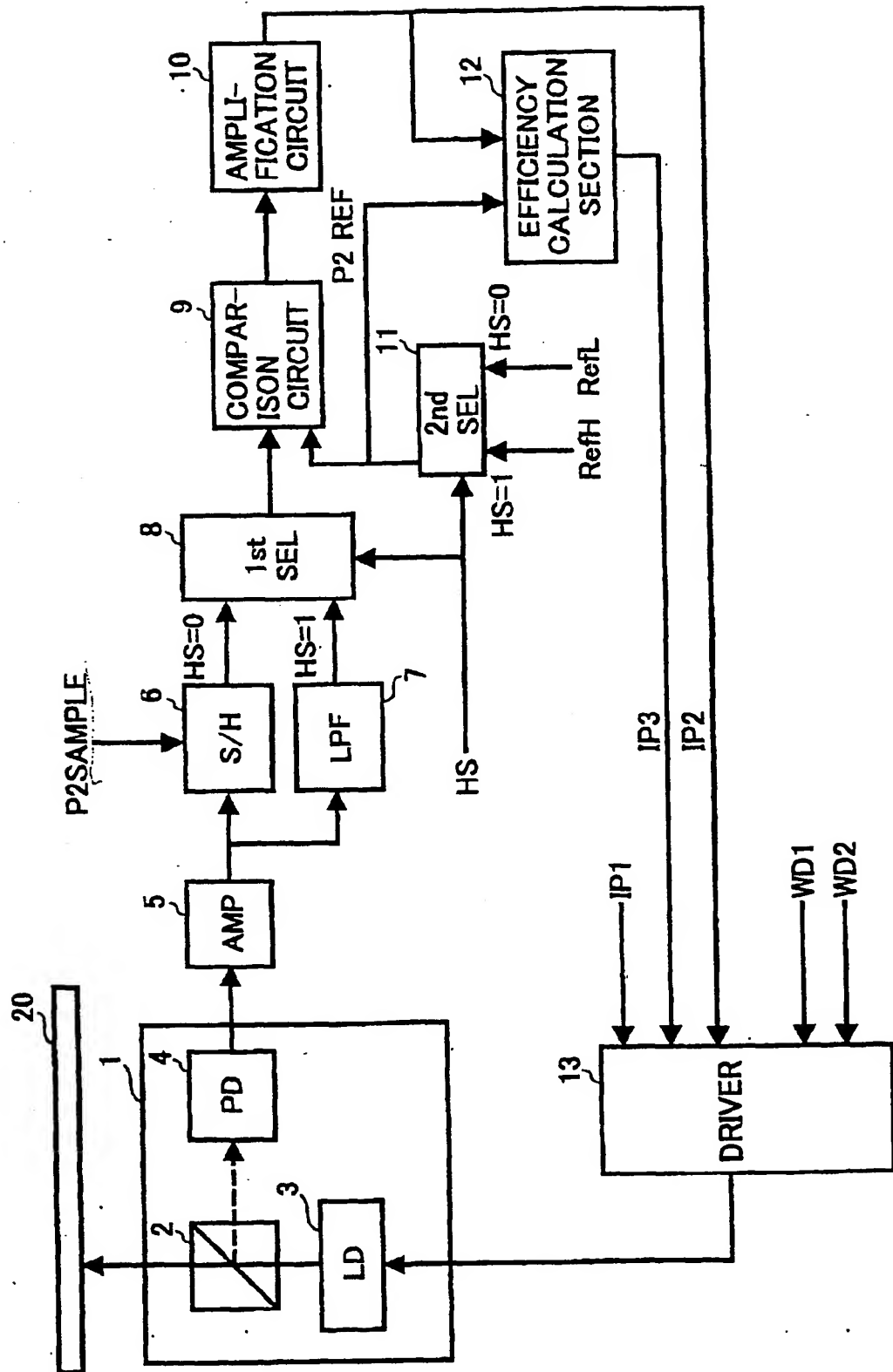


FIG. 2

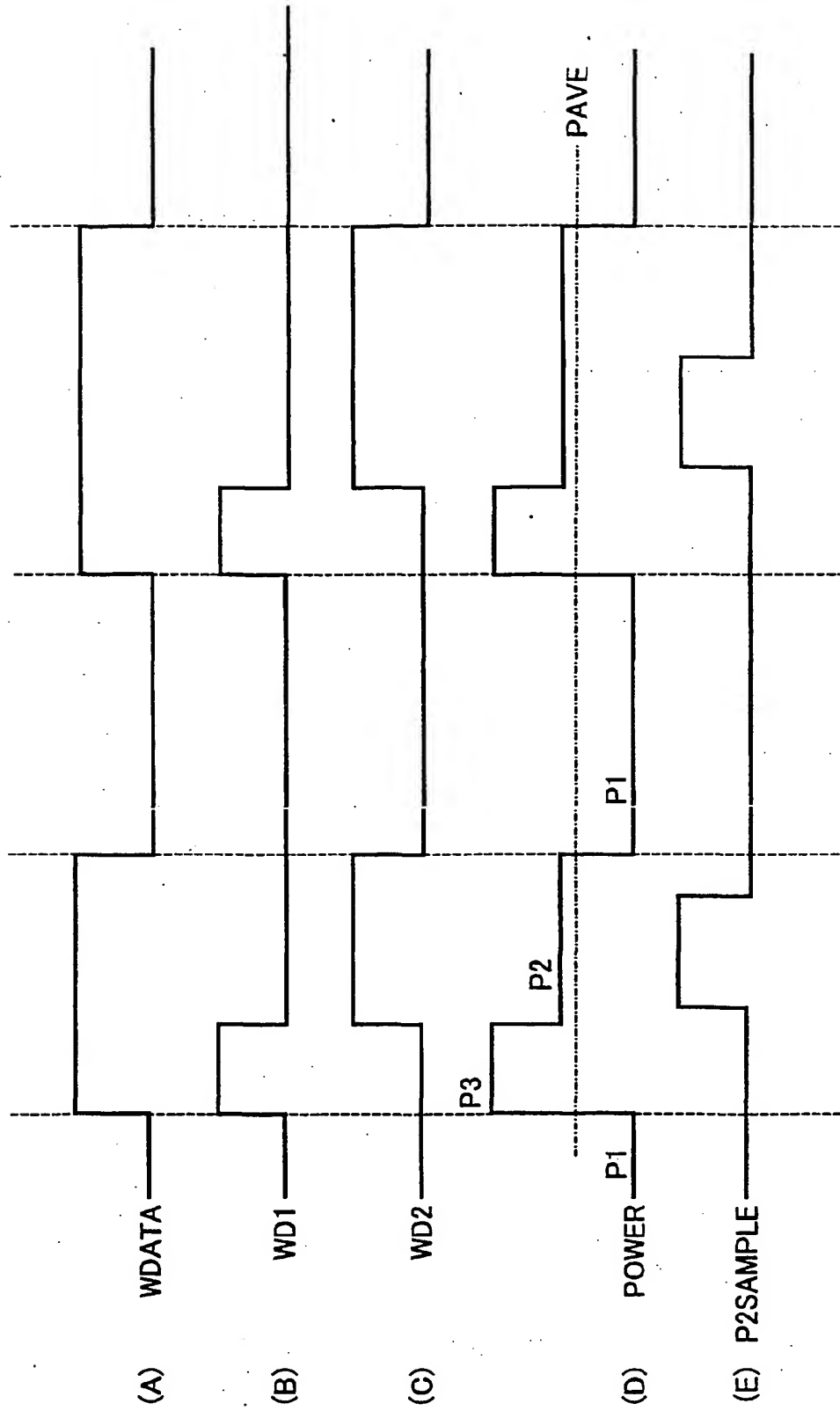


FIG. 3

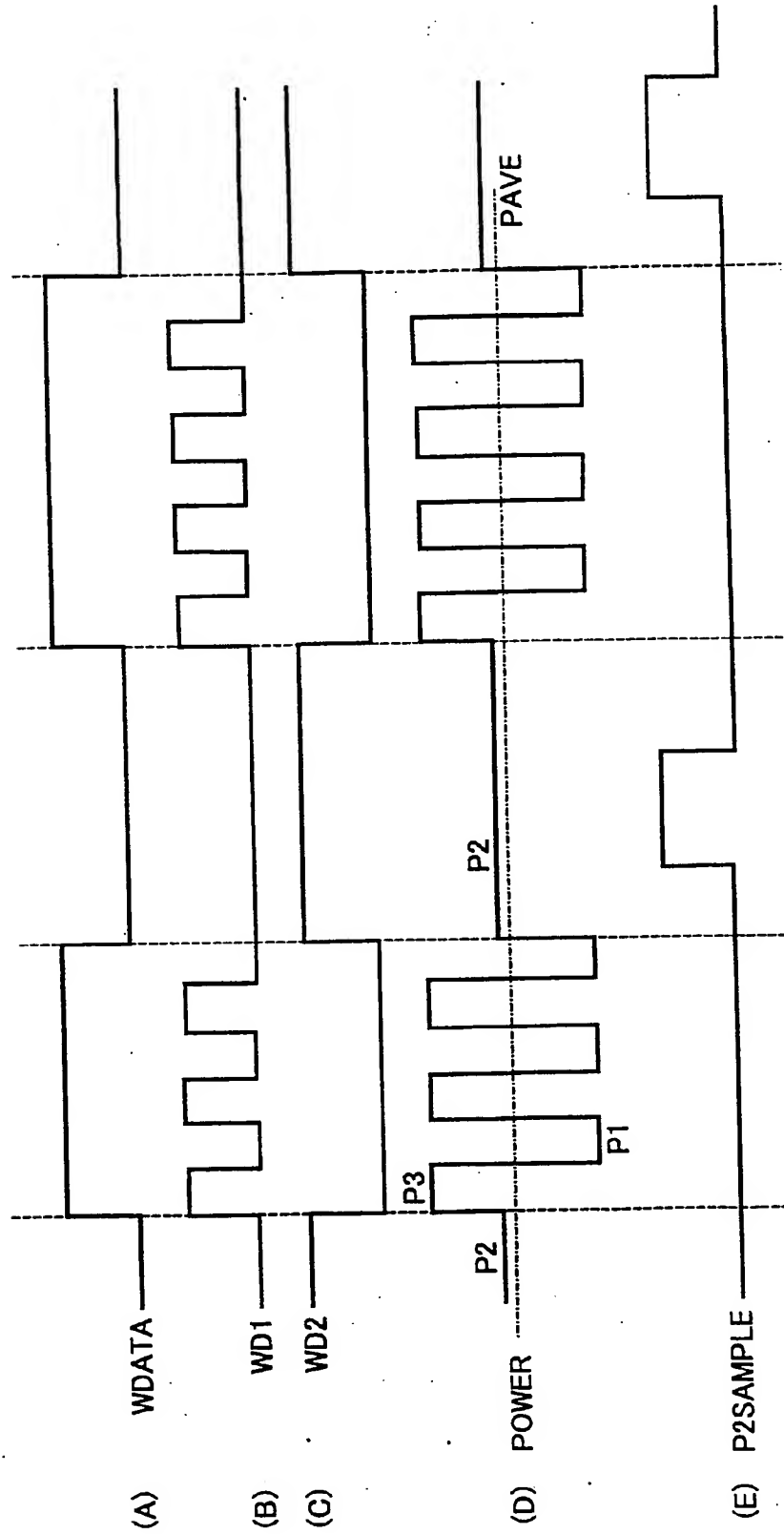


FIG. 4

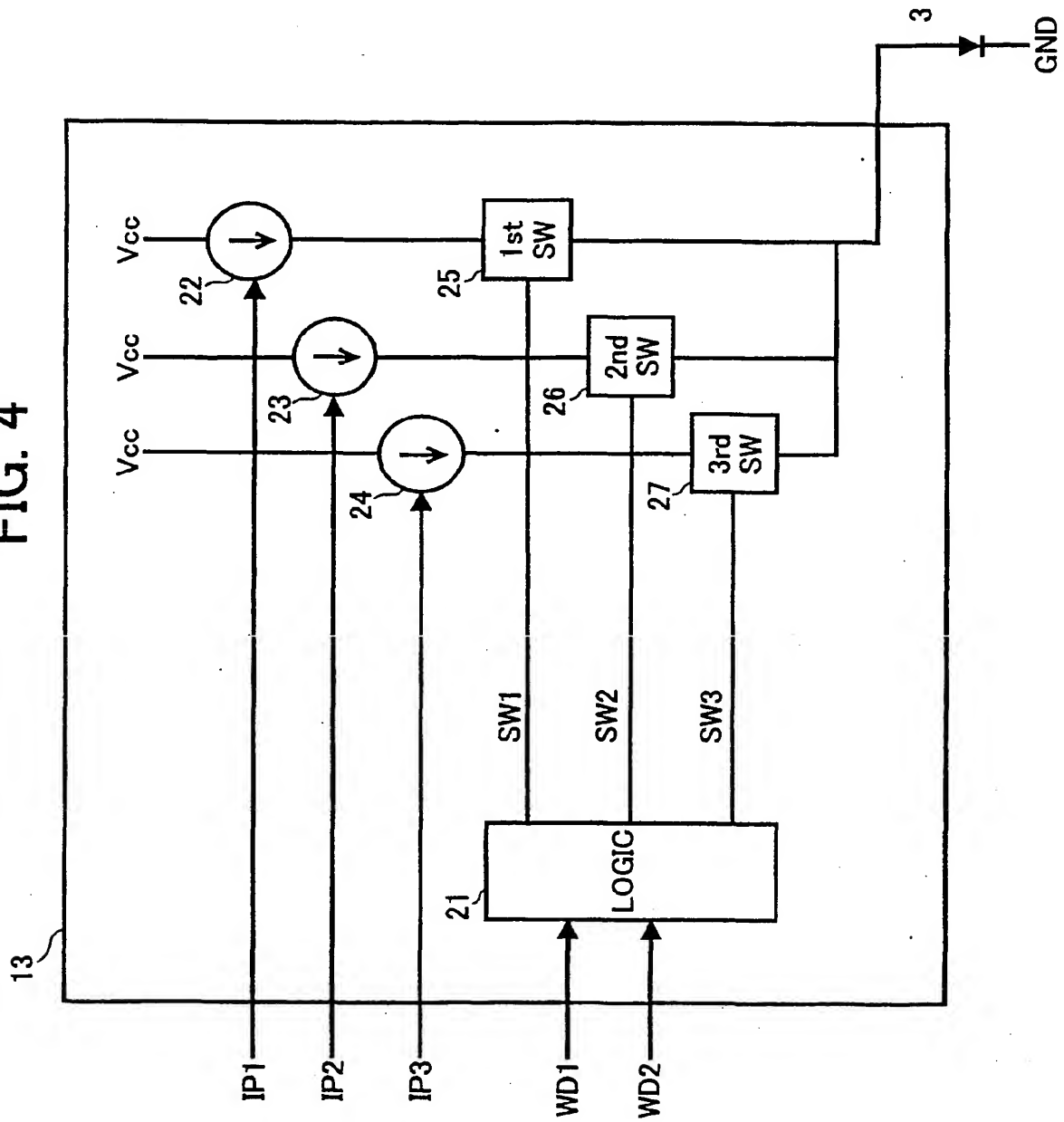
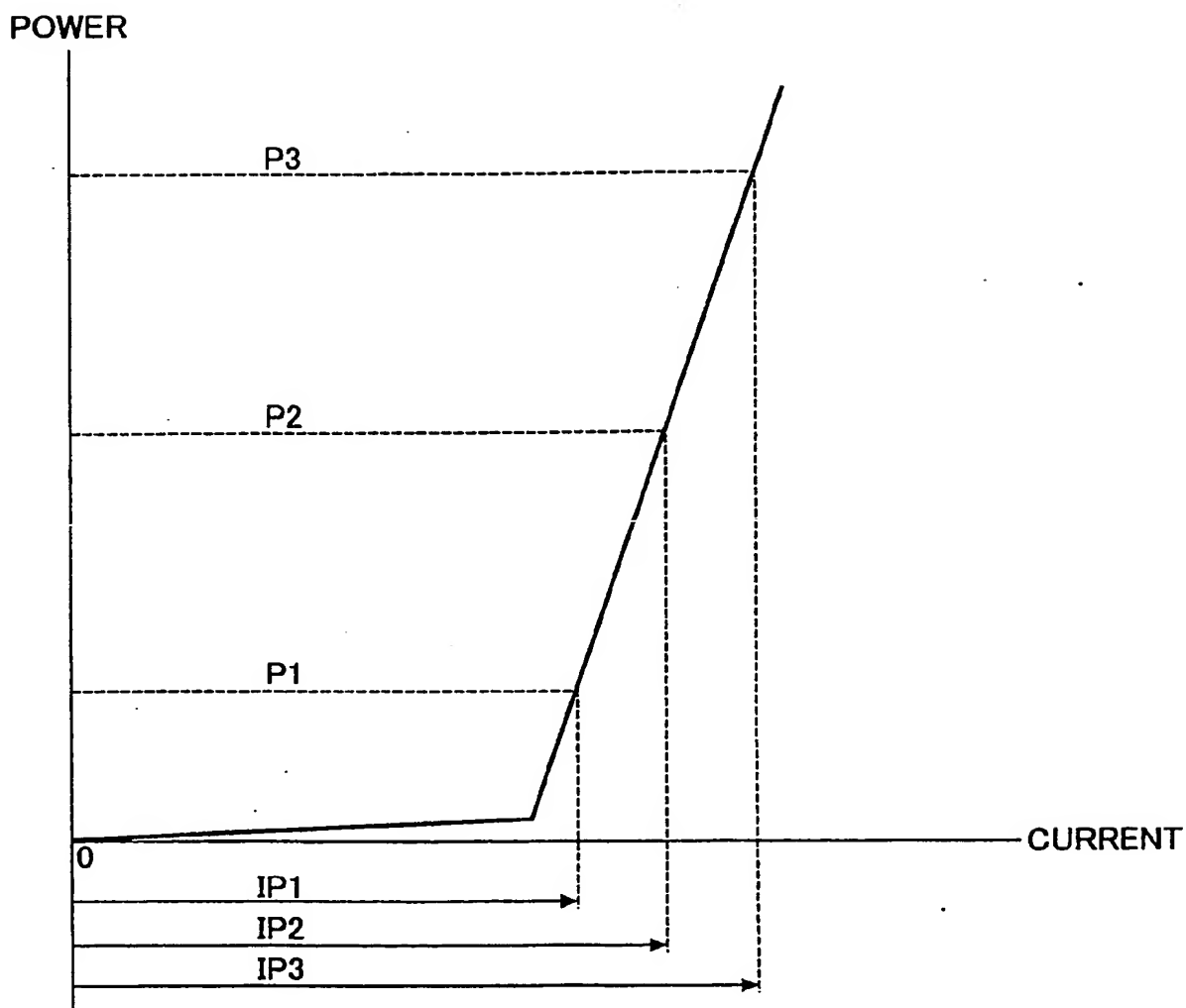


FIG. 5

WD1	WD2	SW1	SW2	SW3
L	L	ON	OFF	OFF
H	L	OFF	OFF	ON
L	H	OFF	ON	OFF
H	H	-	-	-

FIG. 6







European Patent  
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# EUROPEAN SEARCH REPORT

Application Number  
EP 01 12 6562

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Place of search <b>THE HAGUE</b>		Date of completion of the search <b>5 April 2002</b>	Examiner <b>Holubov, C</b>
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